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(54) **Oil additive concentrates and lubricants of enhanced performance capabilities**

Öl-Zusatz-Konzentrate und Schmiermittel mit verbesserten Leistungsmöglichkeiten

Concentrés d'additifs pour l'huile et lubrifiants à capacité améliorée

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EP 0 519 760 B1

Description

[0001] This invention relates to additive concentrates and oleaginous compositions (i.e., lubricating oils and functional fluids) having enhanced properties, especially as regards storage stability, antiwear performance, and extreme pressure performance.

[0002] Heretofore a number of additive concentrates containing, inter alia, sulfur-containing antiwear and/or extreme pressure additives, phosphorus-containing antiwear and/or extreme pressure additives, and other additive components have been proposed and used. Among such other additive components are acidic components such as carboxylic acids, hydrocarbyl phosphoric acids, and hydrocarbyl thiophosphoric acids; basic components such as amines; and ashless dispersants such as boronated succinimides.

[0003] Many such additive concentrates as supplied are highly acidic in character, exhibiting pH values (as determined by the method described hereinafter) in the range of 4.0 to 5.5. Such acidity arises by virtue of use in the concentrates of acidic additives to control wear and corrosion.

[0004] This invention, in part, involves the discovery that when a boronated ashless dispersant is included within an acidic additive concentrate of the foregoing type, a haze tends to develop in the concentrate after a period of storage at ambient temperature. It is believed that under such acidic conditions and in the presence of air, especially air of relatively high humidity, inorganic boron species -- presumably boron oxides or boron acids -- are gradually liberated in the concentrate to thereby form the haze.

[0005] A need thus exists for an effective way of inhibiting haze formation in such additive concentrates especially during exposure to air of relatively high humidity without impairing the performance characteristics of the concentrate and of oils of lubricating viscosity containing the same. Indeed, it would be of inestimable value to have a way of accomplishing this objective while at the same time improving upon the performance capabilities of the compositions involved.

[0006] This invention, in part, further involves the discovery that it is indeed possible to inhibit such haze formation, and further that improvements in performance capabilities can be realized, by suitably controlling the pH of the concentrate as produced. Not only does such pH control result in no sacrifice in wear and corrosion inhibition, but it has been found possible by suitable adjustment and control of pH to actually improve the effectiveness of the concentrate in its ability to inhibit wear and corrosion.

[0007] Moreover, the practice of this invention makes possible the provision of compositions having enhanced extreme pressure properties as seen in the standard L-42 test, and improved antirust performance as seen in the standard L-33 test.

[0008] In accordance with one of its embodiments this invention provides improved methods and compositions wherein an additive concentrate is formed from a combination of components which include (i) one or more (i.e., a complement of) oil-soluble acidic organic additives at least one of which is a hydrocarbyl phosphoric acid or a carboxylic acid, and (ii) one or more oil-soluble ashless boronated dispersants. The improvement involves including in the concentrate one or more oil-soluble amines in an amount such that the pH of the finished concentrate as formed falls in the range of 6.0 to 7.0 (preferably in the range of 6.4 to 7.0, more preferably in the range of 6.60 to 6.95, and most preferably in the range of 6.70 to 6.95), and introducing the boronated dispersant into the concentrate when the pH of the concentrate being formed is at least about 6.0. In each case the aforesaid pH is as determined in accordance with the method described hereinafter.

[0009] Other embodiments of this invention include the following:

I. In an additive concentrate comprising at least one oil-soluble amine salt of a dihydrocarbyl monothiophosphoric acid, at least one oil-soluble active-sulfur-containing antiwear or extreme pressure agent, and a complement of oil-soluble acidic organic additives at least one of which is a hydrocarbyl phosphoric acid, the improvement wherein said concentrate contains a sufficient amount of oil-soluble primary amine to provide a concentrate having a pH in the range of 6.0 to 7.0 as determined in accordance with the method described hereinafter.

II. A concentrate as described in I. above wherein the at least one oil-soluble amine salt is formed by charging to a reactor the following components in the following order: (1) at least one active-sulfur-containing component, (2) at least one dihydrocarbyl hydrogen phosphite, and (3) at least one amine; and while agitating the reactor contents, controlling and maintaining the temperature at 55 to 60°C.

III. A concentrate as described in II. above wherein the at least one active-sulfur-containing compound is sulfurized olefin, wherein the at least one dihydrocarbyl hydrogen phosphite is dialkyl hydrogen phosphite, and wherein the at least one amine comprises aliphatic monoamine having in the range of 8 to 24 carbon atoms per molecule.

IV. A concentrate as described in I. above wherein the pH is in the range of 6.4 to 7.0, more preferably in the range

of 6.60 to 6.95, and most preferably in the range of 6.70 to 6.95.

V. A concentrate as described in I. above wherein the oil-soluble primary amine consists aliphatic monoamines having in the range of 14 to 24 carbon atoms per molecule.

VI. A concentrate as described in V. above wherein such primary amine further includes a small amore monoamine having less than 14 carbon atoms in the molecule, e.g. up to about one third of the we amine of an aliphatic monoamine having from 8 to 13 carbon atoms per molecule.

VII. A concentrate as described in I. above wherein such primary amine consists essentially of a mixture and C_{18} aliphatic monoamines (preferably a mixture of C_{16} and C_{18} saturated and olefinically unsaturated alipt monoamines) together with a small amount of aliphatic monoamine having less than 16 carbon atoms in the mo ecule, e.g. up to about one third the weight of the primary amine of an aliphatic monoamine having from 8 to 15 carbon atoms per molecule, e. g. octylamine.

VIII. A concentrate as described in I. above wherein the complement of oil-soluble acidic organic additives additionally includes (a) at least one aliphatic monocarboxylic acid, (b) at least one aliphatic polycarboxylic acid, or (c) a combination of (a) and (b).

IX. A concentrate as described in I. above further including at least one oil-soluble ashless dispersant.

X. A concentrate as described in IX. above wherein the oil-soluble ashless dispersant is a boron-containing ashless dispersant and wherein the boron-containing ashless dispersant is introduced into the concentrate after the pH thereof is at least about 6.0.

XI. A concentrate as described in I. above further including at least one oil-soluble copper corrosion inhibitor in an amount such that the concentrate exhibits a 1b rating or better in the ASTM D-130 procedure in the form referred to hereinafter.

XII. A concentrate as described in XI. above wherein the pH is in the range of 6.70 to 6.95.

XIII. A concentrate as described in I. above wherein:

A) the oil-soluble amine salt of a dihydrocarbyl monothiophosphoric acid is formed by a process which comprises (i) introducing, at a rate such that the temperature does not exceed about 60°C, dialkyl hydrogen phosphite into sulfurized branched-chain olefin while agitating the mixture so formed, (ii) introducing into this mixture, at a rate such that the temperature does not exceed about 60°C, one or more aliphatic primary monoamines having in the range of 8 to 24, preferably 8 to 20 carbon atoms in the molecule while agitating the mixture so formed, and (iii) maintaining the temperature of the resultant agitated reaction mixture at between 55 and 60°C until reaction is substantially complete;
B) the hydrocarbyl phosphoric acid consists essentially of dialkyl phosphoric acid or a combination of dialkyl phosphoric acid and monoalkyl phosphoric acid, and is present in the reaction mixture of A) during at least a portion of the time (iii) thereof is being conducted;
C) the complement of oil-soluble acidic organic additives includes at least one aliphatic dicarboxylic acid having about 36 carbon atoms in the molecule; and
D) the concentrate further includes at least one oil-soluble copper corrosion inhibitor in an amount such that the concentrate exhibits a 1b rating or better in the ASTM D-130 procedure in the form referred to hereinafter.

XIV. A concentrate as described in XIII. above further including (a) at least one oil-soluble succinimide, (b) at least one oil-soluble succinic ester, or (c) at least one oil-soluble succinic ester-amide, or a combination of any two or all three of (a), (b) and (c).

XV. A concentrate as described in XIII. above further including (a) at least one oil-soluble boronated succinimide, (b) at least one oil-soluble boronated succinic ester, or (c) at least one oil-soluble boronated succinic ester-amide, or (d) a combination of any two or all three of (a), (b) and (c), whichever of the foregoing (a), (b), (c) or (d) is included in the concentrate being introduced therein after the pH thereof is at least about 6.0.

XVI. An ashless additive concentrate formed from at least the following: (a) at least one oil-soluble sulfur-containing antiwear and/or extreme pressure agent, (b) at least one oil-soluble phosphorus-containing antiwear and/or extreme pressure agent, (c) at least one oil-soluble acidic organic additive, (d) at least one oil-soluble amine, and (e) at least one oil-soluble boronated ashless dispersant; such concentrate being further characterized in that (i) in the absence of component (d) the pH of the concentrate is 6.0 or below, (ii) component (d) is employed in an amount sufficient to cause the pH of the concentrate to be in the range of 6.0 to 7.0, and (iii) component (e) is introduced into the concentrate when the pH thereof is at least about 6.0, the determination of the aforesaid pH values being in accordance with the method described hereinafter.

XVII. In the method of forming an additive concentrate from a plurality of oil-soluble components which include at least one acidic organic component and at least one boronated ashless dispersant by blending the components of the concentrate concurrently or sequentially and individually or in one or more sub-combinations, the improvement which comprises (a) including as at least one component in such blending operation a sufficient amount of oil-soluble amine to adjust the pH of the concentrate to at least 6.0, preferably at least 6.4, more preferably at least 6.6, and most preferably at least 6.7, and (b) blending such one or more boronated ashless dispersants into the concentrate such that at no point in the blending is such boronated ashless dispersant exposed to a pH below 6.0 (or, preferably, below 6.4, or, more preferably, below 6.6, or, most preferably, below 6.7), the determination of the aforesaid pH values being in accordance with the method described hereinafter.

XVIII. The improvement according to XVII. above wherein the plurality of oil-soluble components further comprises at least one oil-soluble active-sulfur-containing antiwear and/or extreme pressure agent and at least one oil-soluble phosphorus-containing antiwear and/or extreme pressure agent; wherein the oil-soluble amine consists essentially of one or more aliphatic primary amines; and wherein the pH of the finished concentrate as determined in accordance with the method described hereinafter is in the range of 6.0 and 7.0.

XIX. The improvement according to XVIII. above wherein the plurality of oil-soluble components further comprises at least one oil-soluble copper corrosion inhibitor in an amount such that the concentrate exhibits a 1b rating or better in the ASTM D-130 procedure in the form referred to hereinafter, and wherein said pH of the finished concentrate as formed is in the range of 6.40 to 6.95, and preferably in the range of 6.70 to 6.95.

XX. In an additive concentrate comprising at least one oil-soluble amine salt of a dihydrocarbyl monothiophosphoric acid, at least one oil-soluble active-sulfur-containing antiwear or extreme pressure agent, and a complement of oil-soluble acidic organic additives at least one of which is carboxylic acid, the improvement wherein said concentrate contains a sufficient amount of oil-soluble primary amine to provide a concentrate having a pH in the range of 6.0 to 7.0 as determined in accordance with the method described hereinafter.

The improvements according to I. through XX. above result in enhancement of antiwear and extreme pressure performance as compared to the corresponding more acidic concentrates and to methods involving the corresponding more acidic concentrates. In the case of X. and XV. through XIX. there is additionally achieved the advantage of inhibition of haze formation during storage.

[0010] The above and other embodiments and features of this invention will be apparent from a consideration of the ensuing description.

Amines

[0011] Any oil-soluble, suitably basic amine or combination of amines can be employed in the practice of this invention. Thus use can be made of oil-soluble, suitably basic primary, secondary and tertiary amines, or mixtures thereof, and such amines can be acyclic or cyclic monoamines or polyamines. They can be homocyclic or heterocyclic. And whether cyclic or acyclic, the amines can contain substituents, such as hydroxyl groups, sulfhydryl groups, thioether linkages, and the like, which do not interfere with the performance capabilities of the amine or the compositions in which the substituted amine is incorporated. Such substituents should be such as not to significantly alter the predominantly hydrocarbonaceous character of the organic portion of the amine.

[0012] Generally speaking, the preferred amines are aliphatic amines, especially the saturated or olefinically unsaturated aliphatic primary amines, such as n-octylamine, 2-ethylhexylamine, tert-octylamine, n-decylamine, the C_{10}, C_{12}, C_{14} and C_{16} tertiary alkyl primary amines (either singly or in any combinations thereof, such as a mixture of the C_{12} and C_{14} tertiary alkyl primary amines), n-undecylamine, lauryl amine, hexadecylamine, heptadecylamine, octadecylamine, the C_{22} and C_{24} tertiary alkyl primary amines (either singly or in combination), decenylamine, dodecenylamine, palmitoleylamine, oleylamine, linoleylamine, and eicosenylamine. Also desirable are the saturated or sub-

stantially saturated aliphatic secondary amines, such as di-iso-amylamine, di-n-octylamine, di-(2-ethylhexyl)amine, di-(tert-octyl)amine, di-n-nonylamine, dilauryl amine, di-hexadecylamine, di-octadecylamine, and di-oleylamine.

[0013] Other suitable amines are exemplified by cyclohexyl dimethyl amine, 1,2-propylene diamine, 1,3-propylene diamine, diethylene triamine, triethylene tetramine, tetraethylene pentamine, ethanolamine, diethanolamine, pyridine, morpholine, trioctyl amine, N-(2-aminoethyl)ethanolamine, 2-methylpiperazine, 1,2-bis(N-piperazinyl-ethane), N,N'-bis (N-piperazinyl)piperazine, 2-methylimidazoline, 3-aminopiperidine, 2-aminopyridine, 2-(β-aminoethyl)-3-pyrroline, 3-aminopyrrolidine, N-(3-aminopropyl)morpholine, methylaminopropylene diamine, N-(β-aminoethyl)piperazine, N,N'-di (β-aminoethyl)piperazine, N,N'-di(β-aminoethyl)imidazolidone-2, N-(β-cyanoethyl)ethane-1,2-diamine, 1,3,6,9-tetraaminooctadecane, 1,3,6-triamino-9-oxadecane, N-methyl-1,2-propanediamine, bis(aminopropyl)ethylenediamine, and N-hexylaniline.

[0014] Preferred amines are alkyl monoamines and alkenyl monoamines having from 8 to 24 carbon atoms in the molecule.

[0015] To achieve optimal performance in the L-33 rust test, it is preferred to employ oil-soluble aliphatic amines in which the aliphatic group is a primary aliphatic group. Commercially available mixtures of suitable primary aliphatic amines in the C_{12} to C_{18} range include Armeen O and Armeen OD (Akco Chemical), and Kemamine P-999 (Humko Chemical). To achieve optimal performance in the ASTM D-2711 demulsibility test, it is preferred to use oil-soluble aliphatic amines in which the aliphatic group is a tertiary aliphatic group, most preferably a tertiary alkyl group. Commercially available mixtures of suitable amines of this type include Primene 81-R and Primene JMT amines (Rohm & Haas Chemical Company).

Acidic organic additives

[0016] One preferred type of acidic components which can be used in the compositions of this invention comprises the oil-soluble hydrocarbyl phosphoric acids, such as the monohydrocarbyl phosphoric acids, the dihydrocarbyl phosphoric acids, and mixtures of mono- and dihydrocarbyl phosphoric acids. Sulfur-containing analogs of these hydrocarbyl phosphoric acids can also be employed, such as the monohydrocarbyl monothiophosphoric acids, the dihydrocarbyl monothiophosphoric acids, the monohydrocarbyl dithiophosphoric acids, the dihydrocarbyl dithiophosphoric acids, and the mono- and dihydrocarbyl tetrathiophosphoric acids. Mixtures of two or more of such sulfur-containing ester-acids, and mixtures of one or more hydrocarbyl phosphoric acids with one or more of such sulfur-containing ester-acids can also be used. The hydrocarbyl groups can be acyclic or cyclic and in either case, saturated or unsaturated. They should of course be of suitable size and configuration as to render the ester-acid soluble in the proportion selected for use both in the additive concentrate and in the base oil in which the concentrate is to be employed.

[0017] Examples of such ester-acids include di-n-hexyl phosphoric acid, di-n-octyl phosphoric acid, di-(2-ethylhexyl) phosphoric acid, mono-(2-ethylhexyl) phosphoric acid, di-n-decyl phosphoric acid, monodecyl phosphoric acid, di-n-undecyl phosphoric acid, monoundecyl phosphoric acid, di-n-dodecyl phosphoric acid, monododecyl phosphoric acid, di-n-tridecyl phosphoric acid, monotridecyl phosphoric acid, di-n-tetradecyl phosphoric acid, monotetradecyl phosphoric acid, di-n-hexadecyl phosphoric acid, monohexadecyl phosphoric acid, di-n-octadecyl phosphoric acid, monooctadecyl phosphoric acid, di-oleyl phosphoric acid, monooleyl phosphoric acid, dicyclohexyl phosphoric acid, 2-phenethyl phosphoric acid, dibenzyl phosphoric acid, diphenyl phosphoric acid, di-tolyl phosphoric acid, dicyclohexenyl phosphoric acid, and mixtures of two or more such compounds. Preferred mixtures of the hydrocarbyl phosphoric acids include di-(2-ethylhexyl) phosphoric acid and mono-(2-ethylhexyl) phosphoric acid; di-n-dodecyl phosphoric acid and di-n-tetradecyl phosphoric acid; and diisooctyl phosphoric acid and mono-isooctyl phosphoric acid.

[0018] The hydrocarbyl monothiophosphoric acids are illustrated by such compounds as dibutyl thiophosphoric acid, dihexyl thiophosphoric acid, diheptyl thiophosphoric acid, decyl thiophosphoric acid, octadecyl thiophosphoric acid, di-(methylcycloheptyl) thiophosphoric acid, dixylyl thiophosphoric acid, docosenyl thiophosphoric acid, and mixtures thereof.

[0019] Examples of the hydrocarbyl dithiophosphoric acids include diisopropyl dithiophosphoric acid, 2,4-pentanediyl dithiophosphoric acid, di-sec-butyl dithiophosphoric acid, di-amyl dithiophophoric acid, n-octyl dithiophosphoric acid, di-n-octyl dithiophosphoric acid, hexadecenyl dithiophosphoric acid, di-(2-ethylhexyl) dithiophosphoric acid, diphenyl dithiophosphoric acid, and dibenzyl dithiophosphoric acid. Analogous hydrocarbyl ester-acids of the trithiophosphoric acids and of tetrathiophosphoric acid can also be used, either singly or in admixture with each other, or in admixture with other phosphoric and/or thiophosphoric and/or dithiophosphoric acids.

[0020] Other types of acidic additive components which can be present in the compositions of this invention include oil-soluble monocarboxylic acids and/or polycarboxylic acids, and oil-soluble partially esterified or partially aminated polycarboxylic acids. Such compounds are often used as rust inhibitors or corrosion inhibitors. Examples of such materials include such monocarboxylic acids as 2-ethylhexanoic acid, lauric acid, myristic acid, palmitic acid, oleic acid, linoleic acid, linolenic acid, behenic acid, cerotic acid, and the like. Typical oil-soluble polycarboxylic acids include dimer and trimer acids, such as are produced from tall oil fatty acids, oleic acid, or linoleic acid; alkenylsuccinic acids

in which the alkenyl group contains 10 or more carbon atoms such as, for example, tetrapropenylsuccinic acid, tetradecenylsuccinic acid, and hexadecenylsuccinic acid; long-chain α,ω-dicarboxylic acids in the molecular weight range of 600 to 3000; and other similar materials. Products of this type are currently available from various commercial sources, such as, for example, the dimer and trimer acids sold under the HYSTRENE trademark by the Humco Chemical Division of Witco Chemical Corporation and under the EMPOL trademark by Emery Chemicals. Another useful type of acidic corrosion inhibitors are the half esters of alkenyl succinic acids having 8 to 24 carbon atoms in the alkenyl group with alcohols such as the polyglycols. The corresponding half amides of such alkenyl succinic acids are also useful.

Boronated ashless dispersants

[0021] Typical procedures for producing boronated ashless dispersants involve heating one or more ashless dispersants such as those of the types described hereinafter under the caption "Ashless dispersants" with at least one boron compound under conditions yielding a boron-containing composition. Suitable compounds of boron useful in forming boronated ashless dispersants suitable for use in the compositions of this invention include, for example, boron acids, boron oxides, boron esters, and amine or ammonium salts of boron acids. Illustrative compounds include boric acid (sometimes referred to as orthoboric acid), boronic acid, tetraboric acid, metaboric acid, pyroboric acid, esters of such acids, such as mono-, di-, and tri-organic esters with alcohols or polyols having up to 20 or more carbon atoms (e.g., methanol, ethanol, 2-propanol, propanol, butanols, pentanols, hexanols, ethylene glycol, propylene glycol, trimethylol propane, and diethanol amine), boron oxides such as boric oxide and boron oxide hydrate, and ammonium salts such as ammonium borate, and ammonium pyroborate. While usable, boron halides such as boron trifluoride, boron trichloride, and the like, are undesirable as they tend to introduce halogen atoms into the boronated dispersant, a feature which is detrimental from the environmental, toxicological and conservational standpoints. Amine borane addition compounds and hydrocarbyl boranes can also be used, although they tend to be relatively expensive. The preferred boron reagent is boric acid, H_3BO_3.

[0022] For further details concerning boronated ashless dispersants and procedures for conducting the boronation operation, reference may be had, for example, to the disclosures of U.S. Pat. Nos. 3,087,936; 3,254,025; 3,281,428; 3,282,955; 3,284,410; 3,338,832; 3,344,069; 3,533,945; 3,718,663; 4,097,389; 4,554,086; and 4,634,543.

Active-sulfur-containing antiwear and/or extreme pressure agents

[0023] Typical active-sulfur-containing antiwear and/or extreme pressure additives include dihydrocarbyl polysulfides; sulfurized olefins; sulfurized fatty acid esters of both natural (e.g., sperm oil) and synthetic origins; trithiones; sulfurized thienyl derivatives; sulfurized terpenes; sulfurized oligomers of C_2-C_8 monoolefins; and sulfurized Diels-Alder adducts such as those disclosed in U.S. reissue patent Re 27,331. Specific examples include sulfurized polyisobutene of $\bar{M}n$ 1,100, sulfurized isobutylene, sulfurized triisobutene, dicyclohexyl polysulfide, diphenyl and dibenzyl polysulfide, di-tert-butyl polysulfide, and dinonyl polysulfide.

Phosphorus-containing antiwear and/or extreme pressure agents

[0024] Generally speaking there are two principal categories of phosphorus-containing antiwear and/or extreme pressure agents: metal salts of phosphorus acids, and metal-free phosphorus compounds. The metal salts are the oil-soluble salts of a metal such as copper, cadmium, calcium, magnesium, and most notably, zinc, and of a suitable acidic compound of phosphorus, such as a thiophosphoric acid, a dithiophosphoric acid, a trithiophosphoric acid, a tetrathiophosphoric acid or of a complex acidic product formed by phosphosulfurizing a hydrocarbon such as one or more olefins or terpenes with a reactant such as phosphorus pentasulfide and hydrolyzing the resultant product. Methods of forming such metal salts are well known to those skilled in the art and are extensively described in the patent literature.

[0025] The oil-soluble metal-free phosphorus-containing antiwear and/or extreme pressure agents are for the most part partially or fully esterified acids of phosphorus. Such compounds include for example phosphates, phosphites, phosphonates, phosphonites, and their various sulfur analogs. Examples include monohydrocarbyl phosphites; monohydrocarbyl phosphates; monohydrocarbyl mono-, di-, tri-, and tetrathiophosphites; monohydrocarbyl mono-, di-, tri-, and tetrathiophosphates; dihydrocarbyl phosphites; dihydrocarbyl phosphates; dihydrocarbyl mono-, di-, tri-, and tetrathiophosphites; dihydrocarbyl mono-, di-, tri-, and tetrathiophosphates; trihydrocarbyl phosphites; trihydrocarbylphosphates; trihydrocarbyl mono-, di-, tri-, and tetrathiophosphites; trihydrocarbyl mono-, di-, tri-, and tetrathiophosphates; the various hydrocarbyl phosphonates and thiophosphonates; the various hydrocarbyl phosphonites and thiophosphonites, and analogous oil-soluble derivatives of polyphosphoric and polythiophosphoric acids; and many others. A few specific examples of such compounds are tricresyl phosphate, tributyl phosphite, triphenyl phosphite, tri-

(2-ethylhexyl) phosphate, dihexyl thiop... phate, cresyl diphenyl phosphate, tris(2-butoxyethyl) phosphr... and tris(2-chloroethyl) phosphate.

[0026] Preferred ashless (i.e., metal-free,... agents for use in the practice of this invention are (a) the oil-sol... phosphoric acids, (b) the amine salts of dihydrocarbyl monothiop... such compounds can be made by reacting a mono- and/or dihydro... compound such as are referred to above under the caption "Activ... agents" and one or more primary or secondary amines. Such reactio... can become uncontrollable, if not conducted properly. The preferred meth... process which comprises (i) introducing, at a rate such that the temperature does... dihydrocarbyl hydrogen phosphites, such as a dialkyl hydrogen phosphite, into an... active-sulfur-containing materials, such as sulfurized branched-chain olefin (e.g., isobutyle... taining lene, etc.), while agitating the mixture so formed, (ii) introducing into this mixture, at a rate suc... sure does not exceed about 60°C, one or more aliphatic primary or secondary amines, preferably one... ich primary monoamines having in the range of 8 to 24 carbon atoms per molecule while agitating the mixtur... and (iii) maintaining the temperature of the resultant agitated reaction mixture at between 55 and 60°C until t... is substantially complete. Another suitable way of producing these amine salts is to concurrently introduce all three ... the reactants into the reaction zone at suitable rates and under temperature control such that the temperature does not exceed about 60°C.

Ashless dispersants

[0027] Any of a variety of ashless dispersants can be utilized in the compositions of this invention. These include the following types:

[0028] Type A - Carboxylic Ashless Dispersants. These are reaction products of an acylating agent (e.g., a monocarboxylic acid, dicarboxylic acid, polycarboxylic acid, or derivatives thereof) with one or more polyamines and/or polyhydroxy compounds. These products, herein referred to as carboxylic ashless dispersants, are described in many patents, including British Patent Specification 1,306,529 and the following U. S. Patents: 3,163,603; 3,184,474; 3,215,707; 3,219,666; 3,271,310; 3,272,746; 3,281,357; 3,306,908; 3,311,558; 3,316,177; 3,340,281; 3,341,542; 3,346,493; 3,381,022; 3,399,141; 3,415,750; 3,433,744; 3,444,170; 3,448,048; 3,448,049; 3,451,933; 3,454,607; 3,467,668; 3,522,179; 3,541,012; 3,542,678; 3,574,101; 3,576,743; 3,630,904; 3,632,510; 3,632,511; 3,697,428; 3,725,441; 3,868,330; 3,948,800; 4,234,435; and Re 26,433.

[0029] There are a number of sub-categories of carboxylic ashless dispersants. One such sub-category which constitutes a preferred type for use in the formation of component b) is composed of the polyamine succinamides and more preferably the polyamine succinimides in which the succinic group contains a hydrocarbyl substituent containing at least 30 carbon atoms. The polyamine used in forming such compounds contains at least one primary amino group capable of forming an imide group on reaction with a hydrocarbon-substituted succinic acid or acid derivative thereof such an anhydride, lower alkyl ester, acid halide, or acid-ester. Representative examples of such dispersants are given in U.S. Pat. Nos. 3,172,892; 3,202,678; 3,216,936; 3,219,666; 3,254,025; 3,272,746; and 4,234,435. The alkenyl succinimides may be formed by conventional methods such as by heating an alkenyl succinic anhydride, acid, acid-ester, acid halide, or lower alkyl ester with a polyamine containing at least one primary amino group. The alkenyl succinic anhydride may be made readily by heating a mixture of olefin and maleic anhydride to 180°-220°C. The olefin is preferably a polymer or copolymer of a lower monoolefin such as ethylene, propylene, 1-butene, or isobutene. The more preferred source of alkenyl group is from polyisobutene having a number average molecular weight of up to 100,000 or higher. In a still more preferred embodiment the alkenyl group is a polyisobutenyl group having a number average molecular weight (determined using the method described in detail hereinafter) of 500-5,000, and preferably 700-2,500, more preferably 700-1,400, and especially 800-1,200. The isobutene used in making the polyisobutene is usually (but not necessarily) a mixture of isobutene and other C_4 isomers such as 1-butene. Thus, strictly speaking, the acylating agent formed from maleic anhydride and "polyisobutene" made from such mixtures of isobutene and other C_4 isomers such as 1-butene, can be termed a "polybutenyl succinic anhydride" and a succinimide made therewith can be termed a "polybutenyl succinimide". However, it is common to refer to such substances as "polyisobutenyl succinic anhydride" and "polyisobutenyl succinimide", respectively. As used herein "polyisobutenyl" is used to denote the alkenyl moiety whether made from a highly pure isobutene or a more impure mixture of isobutene and other C_4 isomers such as 1-butene.

[0030] Polyamines which may be employed in forming the ashless dispersant include any that have at least one primary amino group which can react to form an imide group. A few representative examples include branched-chain alkanes containing two or more primary amino groups such as tetraamino-neopentane; polyaminoalkanols such as 2-

(2-aminoethylamino)-ethanol and 2-[2-(2-aminoethylamino)-ethylamino]-ethanol; heterocyclic compounds containing two or more amino groups at least one of which is a primary amino group such as 1-(β-aminoethyl)-2-imidazolidone, 2-(2-aminoethylamino)-5-nitropyridine-3-amino-N-ethylpiperidine, 2-(2-aminoethyl)-pyridine, 5-aminoindole, 3-amino-5-mercapto-1,2,4-triazole, and 4-(aminomethyl)-piperidine; and the alkylene polyamines such as propylene diamine, dipropylene triamine, di-(1,2-butylene)triamine, N-(2-aminoethyl)-1,3-propanediamine, hexamethylenediamine and tetra-(1,2-propylene)pentamine.

[0031] The most preferred amines are the ethylene polyamines which can be depicted by the formula

$$H_2N(CH_2CH_2NH)_nH$$

wherein n is an integer from one to ten. These include: ethylene diamine, diethylene triamine, triethylene tetramine, tetraethylene pentamine, pentaethylene hexamine, and the like, including mixtures thereof in which case n is the average value of the mixture. These ethylene polyamines have a primary amine group at each end so can form mono-alkenylsuccinimides and bis-alkenylsuccinimides. Commercially available ethylene polyamine mixtures usually contain minor amounts of branched species and cyclic species such as N-aminoethyl piperazine, N,N'-bis(aminoethyl)piperazine, and N,N'-bis(piperazinyl)ethane. The preferred commercial mixtures have approximate overall compositions falling in the range corresponding to diethylene triamine to pentaethylene hexamine, mixtures generally corresponding in overall makeup to tetraethylene pentamine being most preferred. Methods for the production of polyalkylene polyamines are known and reported in the literature. See for example U.S. Pat. No. 4,827,037 and references cited therein.

[0032] Thus especially preferred ashless dispersants for use in the present invention are the products of reaction of a polyethylene polyamine, e.g., triethylene tetramine or tetraethylene pentamine, with a hydrocarbon-substituted carboxylic acid or anhydride (or other suitable acid derivative) made by reaction of a polyolefin, preferably polyisobutene, having a number average molecular weight of 500 to 5,000, preferably 700 to 2,500, more preferably 700 to 1,400 and especially 800 to 1,200, with an unsaturated polycarboxylic acid or anhydride, e.g., maleic anhydride, maleic acid, fumaric acid, or mixtures of two or more such substances.

[0033] As used herein the term "succinimide" is meant to encompass the completed reaction product from reaction between the amine reactant(s) and the hydrocarbon-substituted carboxylic acid or anhydride (or like acid derivative) reactant(s), and is intended to encompass compounds wherein the product may have amide, amidine, and/or salt linkages in addition to the imide linkage of the type that results from the reaction of a primary amino group and an anhydride moiety.

[0034] Residual unsaturation in the alkenyl group of the alkenyl succinimide may be used as a reaction site, if desired. For example the alkenyl substituent may be hydrogenated to form an alkyl substituent. Similarly the olefinic bond(s) in the alkenyl substituent may be sulfurized, halogenated, or hydrohalogenated. Ordinarily, there is little to be gained by use of such techniques, and thus the use of alkenyl succinimides as the precursor of component b) is preferred.

[0035] Another sub-category of carboxylic ashless dispersants which can be used in the compositions of this invention includes alkenyl succinic acid esters and diesters of alcohols containing 1-20 carbon atoms and 1-6 hydroxyl groups. Representative examples are described in U.S. Pat. Nos. 3,331,776; 3,381,022; and 3,522,179. The alkenyl succinic portion of these esters corresponds to the alkenyl succinic portion of the succinimides described above including the same preferred and most preferred subgenus, e.g., alkenyl succinic acids and anhydrides, where the alkenyl group contains at least 30 carbon atoms and notably, polyisobutenyl succinic acids and anhydrides wherein the polyisobutenyl group has a number average molecular weight of 500 to 5,000, preferably 700 to 2,500, more preferably 700 to 1,400, and especially 800 to 1,200. As in the case of the succinimides, the alkenyl group can be hydrogenated or subjected to other reactions involving olefinic double bonds.

[0036] Alcohols useful in preparing the esters include methanol, ethanol, 2-methylpropanol, octadecanol, eicosanol, ethylene glycol, diethylene glycol, tetraethylene glycol, diethylene glycol monoethylether, propylene glycol, tripropylene glycol, glycerol, sorbitol, 1,1,1-trimethylol ethane, 1,1,1-trimethylol propane, 1,1,1-trimethylol butane, pentaerythritol, and dipentaerythritol.

[0037] The succinic esters are readily made by merely heating a mixture of alkenyl succinic acid, anhydrides or lower alkyl (e.g., C_1-C_4) ester with the alcohol while distilling out water or lower alkanol. In the case of acid-esters less alcohol is used. In fact, acid-esters made from alkenyl succinic anhydrides do not evolve water. In another method the alkenyl succinic acid or anhydrides can be merely reacted with an appropriate alkylene oxide such as ethylene oxide, propylene oxide, and mixtures thereof.

[0038] Still another sub-category of carboxylic ashless dispersants useful in forming compositions of this invention comprises an alkenyl succinic ester-amide mixture. These may be made by heating the above-described alkenyl succinic acids, anhydrides or lower alkyl esters with an alcohol and an amine either sequentially or in a mixture. The alcohols and amines described above are also useful in this embodiment. Alternatively, amino alcohols can be used

alone or with the alcohol and/or amine to form the ester-amide mixtures. The amino alcohol can contain 1-20 carbon atoms, 1-6 hydroxy groups and 1-4 amine nitrogen atoms. Examples are ethanolamine, diethanolamine, N-ethanol-diethylene triamine, and trimethylol aminomethane.

[0039] Here again, the alkenyl group of the succinic ester-amide can be hydrogenated or subjected to other reactions involving olefinic double bonds.

[0040] Representative examples of suitable ester-amide mixtures are referred to in U.S. Pat. Nos. 3,184,474; 3,576,743; 3,632,511; 3,804,763; 3,836,471; 3,862,981; 3,936,480; 3,948,800; 3,950,341; 3,957,854; 3,957,855; 3,991,098; 4,071,548; and 4,173,540.

[0041] Yet another sub-category of carboxylic ashless dispersants which can be used comprises the Mannich-based derivatives of hydroxyaryl succinimides. Such compounds can be made by reacting a polyalkenyl succinic anhydride with an aminophenol to produce an N-(hydroxyaryl) hydrocarbyl succinimide which is then reacted with an alkylene diamine or polyalkylene polyamine and an aldehyde (e.g., formaldehyde), in a Mannich-base reaction. Details of such synthesis are set forth in U.S. Pat. No. 4,354,950. As in the case of the other carboxylic ashless dispersants discussed above, the alkenyl succinic anhydride or like acylating agent is derived from a polyolefin, preferably a polyisobutene, having a number average molecular weight of 500 to 5,000, preferably 700 to 2,500, more preferably 700 to 1,400, and especially 800 to 1,200. Likewise, residual unsaturation in the polyalkenyl substituent group can be used as a reaction site as for example, by hydrogenation, sulfurization, or the like.

[0042] Type B - Mannich polyamine dispersants. This category of ashless dispersant which can be utilized in the compositions of this invention is comprised of reaction products of an alkyl phenol, with one or more aliphatic aldehydes containing from 1 to 7 carbon atoms (especially formaldehyde and derivatives thereof), and polyamines (especially polyalkylene polyamines of the type described hereinabove). Examples of these Mannich polyamine dispersants are described in the following U.S. Patents: 2,459,112; 2,962,442; 2,984,550; 3,036,003; 3,166,516; 3,236,770; 3,368,972; 3,413,347; 3,442,808; 3,448,047; 3,454,497; 3,459,661; 3,493,520; 3,539,633; 3,558,743; 3,586,629; 3,591,598; 3,600,372; 3,634,515; 3,649,229; 3,697,574; 3,703,536; 3,704,308; 3,725,277; 3,725,480; 3,726,882; 3,736,357; 3,751,365; 3,756,953; 3,793,202; 3,798,165; 3,798,247; 3,803,039; 3,872,019; 3,980,569; and 4,011,380.

[0043] The polyamine group of the Mannich polyamine dispersants is derived from polyamine compounds characterized by containing a group of the structure -NH- wherein the two remaining valances of the nitrogen are satisfied by hydrogen, amino, or organic radicals bonded to said nitrogen atom. These compounds include aliphatic, aromatic, heterocyclic and carbocyclic polyamines. The source of the oil-soluble hydrocarbyl group in the Mannich polyamine dispersant is a hydrocarbyl-substituted hydroxy aromatic compound comprising the reaction product of a hydroxy aromatic compound, according to well known procedures, with a hydrocarbyl donating agent or hydrocarbon source. The hydrocarbyl substituent provides substantial oil solubility to the hydroxy aromatic compound and preferably, is substantially aliphatic in character. Commonly, the hydrocarbyl substituent is derived from a polyolefin having at least about 40 carbon atoms. The hydrocarbon source should be substantially free from pendant groups which render the hydrocarbyl group oil insoluble. Examples of acceptable substituent groups are halide, hydroxy, ether, carboxy, ester, amide, nitro and cyano. However, these substituent groups preferably comprise no more than about 10 weight percent of the hydrocarbon source.

[0044] The preferred hydrocarbon sources for preparation of the Mannich polyamine dispersants are those derived from substantially saturated petroleum fractions and olefin polymers, preferably polymers of mono-olefins having from 2 to 30 carbon atoms. The hydrocarbon course can be derived, for example, from polymers of olefins such as ethylene, propene, 1-butene, isobutene, 1-octene, 1-methylcyclohexene, 2-butene and 3-pentene. Also useful are copolymers of such olefins with other polymerizable olefinic substances such as styrene. In general, these copolymers should contain at least 80 percent and preferably 95 percent, on a weight basis, of units derived from the aliphatic mono-olefins to preserve oil solubility. The hydrocarbon source generally contains at least 40 and preferably at least 50 carbon atoms to provide substantial oil solubility to the dispersant. The olefin polymers having a number average molecular weight between 600 and 5,000 are preferred for reasons of easy reactivity and low cost. However, polymers of higher molecular weight can also be used. Especially suitable hydrocarbon sources are isobutylene polymers.

[0045] The Mannich polyamine dispersants are generally prepared by reacting a hydrocarbyl-substituted hydroxy aromatic compound with an aldehyde and a polyamine. Typically, the substituted hydroxy aromatic compound is contacted with from 0.1 to 10 moles of polyamine and 0.1 to 10 moles of aldehyde per mole of substituted hydroxy aromatic compound. The reactants are mixed and heated to a temperature above about 80°C. to initiate the reaction. Preferably, the reaction is carried out at a temperature from 100° to 250 °C. The resulting Mannich product has a predominantly benzylamine linkage between the aromatic compound and the polyamine. The reaction can be carried out in an inert diluent such as mineral oil, benzene, toluene, naphtha, or ligroin to facilitate control of viscosity, temperature and reaction rate.

[0046] Suitable polyamines for use in preparation of the Mannich polyamine dispersants include, but are not limited to, methylene polyamines, ethylene polyamines, butylene polyamines, propylene polyamines, pentylene polyamines, hexylene polyamines and heptylene polyamines. The higher homologs of such amines and related aminoalkyl-substi-

tuted piperazines are also useful. Specific examples of such polyamines include ethylene diamine, triethylene tetramine, tris(2-aminoethyl)amine, propylene diamine, pentamethylene diamine, hexamethylene diamine, heptamethylene diamine, octamethylene diamine, decamethylene diamine, di(heptamethylene) triamine, pentaethylene hexamine, di(trimethylene) triamine, 2-heptyl-3-(2-aminopropyl)imidazoline, 1,3-bis(2-aminoethyl)imidazoline, 1-(2-aminopropyl)piperazine, 1,4-bis(2-aminoethyl)piperazine and 2-methyl-1-(2-aminobutyl)piperazine. Higher homologs, obtained by condensing two or more of the above mentioned amines, are also useful, as are the polyoxyalkylene polyamines.

[0047] The polyalkylene polyamines, examples of which are set forth above, are especially useful in preparing the Mannich polyamine dispersants for reasons of cost and effectiveness. Such polyamines are described in detail under the heading "Diamines and Higher Amines" in Kirk-Othmer, Encyclopedia of Chemical Technology, Second Edition, Vol. 7, pp. 22-39. They are prepared most conveniently by the reaction of an ethylene imine with a ring-opening reagent such as ammonia. These reactions result in the production of somewhat complex mixtures of polyalkylene polyamines which include cyclic condensation products such as piperazines. Because of their availability, these mixtures are particularly useful in preparing the Mannich polyamine dispersants. However, it will be appreciated that satisfactory dispersants can also be obtained by use of pure polyalkylene polyamines.

[0048] Alkylene diamines and polyalkylene polyamines having one or more hydroxyalkyl substituents on the nitrogen atom are also useful in preparing the Mannich polyamine dispersants. These materials are typically obtained by reaction of the corresponding polyamine with an epoxide such as ethylene oxide or propylene oxide. Preferred hydroxyalkyl-substituted diamines and polyamines are those in which the hydroxyalkyl groups have less than about 10 carbon atoms. Examples of suitable hydroxyalkyl-substituted diamines and polyamines include, but are not limited to, N-(2-hydroxyethyl)ethylenediamine, N,N'-bis(2-hydroxyethyl)ethylenediamine, mono(hydroxypropyl)diethlenetriamine,(di(hydroxypropyl)tetraethylenepentamine and N-(3-hydroxybutyl)tetramethylenediamine. Higher homologs obtained by condensation of the above mentioned hydroxyalkyl-substituted diamines and polyamines through amine groups or through ether groups are also useful.

[0049] Type C - Polymeric polyamine dispersants. Also suitable for use in the compositions of this invention are polymers containing basic amine groups and oil solubilizing groups (for example, pendant alkyl groups having at least about 8 carbon atoms). Such polymeric dispersants are herein referred to as polymeric polyamine dispersants. Such materials include, but are not limited to, interpolymers of decyl methacrylate, vinyl decyl ether or a relatively high molecular weight olefin with aminoalkyl acrylates and aminoalkyl acrylamides. Examples of polymeric polyamine dispersants are set forth in the following patents: U.S. Pat. Nos. 3,329,658; 3,449,250; 3,493,520; 3,519,565; 3,666,730; 3,687,849; 3,702,300.

[0050] Type D - Post-treated ashless dispersants. Any of the ashless dispersants referred to above as types A-C can be subjected to post-treatment with one or more suitable reagents such as urea, thiourea, carbon disulfide, aldehydes, ketones, carboxylic acids, anhydrides of low molecular weight dibasic acids, nitriles, epoxides, phosphorus acids, and phosphorus esters. Such post-treated ashless dispersants can be used in forming the compositions of this invention. Examples of post-treatment procedures and post-treated ashless dispersants are set forth in the following U.S. Patents: U.S. Pat. Nos. 3,036,003; 3,200,107; 3,216,936; 3,256,185; 3,278,550; 3,312,619; 3,366,569; 3,367,943; 3,373,111; 3,403,102; 3,442,808; 3,455,831; 3,455,832; 3,493,520; 3,502,677; 3,513,093; 3,573,010; 3,579,450; 3,591,598; 3,600,372; 3,639,242; 3,649,229; 3,649,659; 3,702,757; and 3,708,522; and 4,971,598.

[0051] Mannich-based derivatives of hydroxyaryl succinimides that have been post-treated with C_5-C_9 lactones such as ε-caprolactone and optionally with other post-treating agents as described for example in U.S. Pat. No. 4,971,711 can also be utilized in the practice of this invention. Additional suitable ashless dispersants which may be utilized are disclosed in U.S. Pat. Nos. 4,820,432; 4,828,742; 4,866,135; 4,866,139; 4,866,140; 4,866,141; 4,866,142; 4,906,394; and 4,913,830.

Copper corrosion inhibitors

[0052] One type of such additives is comprised of thiazoles, triazoles and thiadiazoles. Examples of such compounds include benzotriazole, tolyltriazole, octyltriazole, decyltriazole, dodecyltriazole, 2-mercaptobenzothiazole, 2,5-dimercapto-1,3,4-thiadiazole,2-mercapto-5-hydrocarbylthio-1,3,4-thiadiazoles, 2-mercapto-5-hydrocarbyldithio-1,3,4-thiadiazoles, 2,5-bis(hydrocarbylthio)-1,3,4-thiadiazoles, and 2,5-(bis)hydrocarbyldithio)1,3,4-thiadiazoles. The preferred compounds are the 1,3,4-thiadiazoles, especially the 2,5-bis(hydrocarbyldithio)-1,3,4-thiadiazoles, a number of which are available as articles of commerce e.g. 2,5-dimethylthio-1,3,4-thiadiazole. Such compounds are generally synthesized from hydrazine and carbon disulfide by known procedures. See for example U.S. Pat. Nos. 2,749,311; 2,760,933; 2,765,289; 2,850,453; 2,910,439; 3,663,561; 3,862,798; 3,840,549; and 4,097,387.

[0053] Other suitable corrosion inhibitors include ether amines; polyethoxylated compounds such as ethoxylated amines, ethoxylated phenols, and ethoxylated alcohols; and imidazolines. Materials of these types are well known to those skilled in the art and a number of such materials are available as articles of commerce.

Other Additive Components

[0054] The oleaginous fluids and additive concentrates of this invention can and preferably will contain additional components in order to partake of the properties which can be conferred to the overall composition by such additional components. The nature of such components will, to a large extent, be governed by the particular use to which the ultimate oleaginous composition (lubricant or functional fluid) is to be subjected.

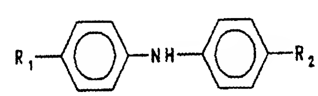
[0055] Antioxidants. Most oleaginous compositions will contain a conventional quantity of one or more antioxidants in order to protect the composition from premature degradation in the presence of air, especially at elevated temperatures. Typical antioxidants include hindered phenolic antioxidants, secondary aromatic amine antioxidants, sulfurized phenolic antioxidants, oil-soluble copper compounds, and phosphorus-containing antioxidants.

[0056] Illustrative sterically hindered phenolic antioxidants include ortho-alkylated phenolic compounds such as 2,6-di-tert-butylphenol, 4-methyl-2,6-di-tert-butylphenol, 2,4,6-tri-tert-butylphenol, 2-tert-butylphenol, 2,6-diisopropylphenol, 2-methyl-6-tert-butylphenol, 2,4-dimethyl-6-tert-butylphenol, 4-(N,N-dimethylaminomethyl)-2,6-di-tert-butylphenol, 4-ethyl-2,6-di-tert-butylphenol, 2-methyl-6-styrylphenol, 2,6-di-styryl-4-nonylphenol, and their analogs and homologs. Mixtures of two or more such mononuclear phenolic compounds are also suitable.

[0057] The preferred antioxidants for use in the compositions of this invention are methylene-bridged alkylphenols, and these can be used singly or in combinations with each other, or in combinations with sterically-hindered unbridged phenolic compounds. Illustrative methylene bridged compounds include 4,4'-methylenebis-(6-tert-butyl-o-cresol), 4,4'-methylenebis(2-tert-amyl-o-cresol), 2,2'-methylene-bis(4-methyl- 6-tert-butylphenol), and 4,4'-methylene-bis(2,6-di-tert-butylphenol). Particularly preferred are mixtures of methylene-bridged alkylphenols such as are described in U.S. Pat. No. 3,211,652.

[0058] Amine antioxidants, especially oil-soluble aromatic secondary amines can also be used in the compositions of this invention. Although aromatic secondary monoamines are preferred, aromatic secondary polyamines are also suitable. Illustrative aromatic secondary monoamines include diphenylamine, alkyl diphenylamines containing 1 or 2 alkyl substituents each having up to about 16 carbon atoms, phenyl-a-naphthylamine, phenyl-β-naphthylamine, alkyl- or aralkyl-substituted phenyl-a-naphthylamine containing one or two alkyl or aralkyl groups each having up to about 16 carbon atoms, and alkyl- or aralkyl-substituted phenyl-β-naphthylamine containing one or two alkyl or aralkyl groups each having up to about 16 carbon atoms.

[0059] A preferred type of aromatic amine antioxidant is an alkylated diphenylamine of the general formula



wherein R_1 is an alkyl group (preferably a branched alkyl group) having 8 to 12 carbon atoms (more preferably 8 or 9 carbon atoms) and R_2 is a hydrogen atom or an alkyl group (preferably a branched alkyl group) having 8 to 12 carbon atoms (more preferably 8 or 9 carbon atoms). Most preferably, R_1 and R_2 are the same. One such preferred compound is available commercially as Naugalube 438L, a material which is understood to be predominately a 4,4'-dinonyldiphenylamine (i.e., bis(4-nonylphenyl)amine) wherein the nonyl groups are branched.

[0060] Another useful type of antioxidant for inclusion in the compositions of this invention is comprised of one or more liquid, partially sulfurized phenolic compounds such as are prepared by reacting sulfur monochloride with a liquid mixture of phenols -- at least about 50 weight percent of which mixture of phenols is composed of one or more reactive, hindered phenols -- in proportions to provide from 0.3 to 0.7 mole of sulfur monochloride per mole of reactive, hindered phenol so as to produce a liquid product. Typical phenol mixtures useful in making such liquid product compositions include a mixture containing by weight 75% of 2,6-di-tert-butylphenol, 10% of 2-tert-butylphenol, 13% of 2,4,6-tri-tert-butylphenol, and 2% of 2,4-di-tert-butylphenol. The reaction is exothermic and thus is preferably kept within the range of 15°C to 70°C, most preferably between 40°C to 60°C.

[0061] Mixtures of different antioxidants can also be used. One suitable mixture is comprised of a combination of (i) an oil-soluble mixture of at least three different sterically-hindered tertiary butylated monohydric phenols which is in the liquid state at 25°C, (ii) an oil-soluble mixture of at least three different sterically-hindered tertiary butylated methylene-bridged polyphenols, and (iii) at least one bis(4-alkyl-phenyl)amine wherein the alkyl group is a branched alkyl group having 8 to 12 carbon atoms, the proportions of (i), (ii) and (iii) on a weight basis falling in the range of 3.5 to 5.0 parts of component (i) and 0.9 to 1.2 parts of component (ii) per part by weight of component (iii).

Base oils

[0062] The additive combinations of this invention can be incorporated in a wide variety of lubricants and functional fluids in effective amounts to provide suitable active ingredient concentrations. The base oils not only can be hydrocarbon oils of lubricating viscosity derived from petroleum (or tar sands, coal, or shale), but also can be natural oils of suitable viscosities such as rapeseed oil, and synthetic oils such as hydrogenated polyolefin oils; poly-α-olefins (e.g., hydrogenated or unhydrogenated α-olefin oligomers such as hydrogenated poly-1-decene); alkyl esters of dicarboxylic acids; complex esters of dicarboxylic acid, polyglycol and alcohol; alkyl esters of carbonic or phosphoric acids; polysilicones; fluorohydrocarbon oils; and mixtures of mineral, natural and/or synthetic oils in any proportion. The term "base oil" for this disclosure includes all the foregoing.

[0063] The additive combinations of this invention can thus be used in lubricating oil and functional fluid compositions, such as automotive crankcase lubricating oils, automatic transmission fluids, gear oils, hydraulic oils, and cutting oils, in which the base oil of lubricating viscosity is a mineral oil, a synthetic oil, a natural oil such as a vegetable oil, or a mixture thereof, e.g., a mixture of a mineral oil and a synthetic oil.

[0064] Suitable mineral oils include those of appropriate viscosity refined from crude oil of any source including Gulf Coast, Midcontinent, Pennsylvania, California, Alaska, Middle East, and North Sea. Standard refinery operations may be used in processing the mineral oil. Among the general types of petroleum oils useful in the compositions of this invention are solvent neutrals, bright stocks, cylinder stocks, residual oils, hydrocracked base stocks, paraffin oils including pale oils, and solvent extracted naphthenic oils. Such oils and blends of them are produced by a number of conventional techniques which are widely known by those skilled in the art.

[0065] Also useful as base oils or as components of base oils are hydrogenated or unhydrogenated liquid oligomers of C_6-C_{16} α-olefins, such as hydrogenated or unhydrogenated oligomers formed from 1-decene. Methods for the production of such liquid oligomeric 1-alkene hydrocarbons are known and reported in the literature. See for example U. S. Pat. Nos. 3,749,560; 3,763,244; 3,780,128; 4,172,855; 4,218,330; 4,902,846; 4,906,798; 4,910,355; 4,911,758; 4,935,570; 4,950,822; 4,956,513; and 4,981,578. Additionally, hydrogenated 1-alkene oligomers of this type are available as articles of commerce.

[0066] Blends of such materials can also be used in order to adjust the viscometrics of the given base oil. Suitable 1-alkene oligomers are also available from other suppliers. As is well known, hydrogenated oligomers of this type contain little, if any, residual ethylenic unsaturation.

[0067] It is also possible in accordance with this invention to utilize blends of one or more liquid hydrogenated 1-alkene oligomers in combination with other oleaginous materials having suitable viscosities, provided that the resultant blend has suitable compatibility and possesses the physical properties desired.

[0068] Typical natural oils that may be used as base oils or as components of the base oils include castor oil, olive oil, peanut oil, rapeseed oil, corn oil, sesame oil, cottonseed oil, soybean oil, sunflower oil, safflower oil, hemp oil, linseed oil, tung oil, oiticica oil, and jojoba oil. Such oils may be partially or fully hydrogenated, if desired.

[0069] The fact that the base oils used in the compositions of this invention may be composed of (i) one or more mineral oils, (ii) one or more synthetic oils, (iii) one or more natural oils, or (iv) a blend of (i) and (ii), or (i) and (iii), or (ii) and (iii), or (i), (ii) and (iii) does not mean that these various types of oils are necessarily equivalents of each other. Certain types of base oils may be used in certain compositions for the specific properties they possess such as high temperature stability, non-flammability or lack of corrosivity towards specific metals (e.g. silver or cadmium). In other compositions, other types of base oils may be preferred for reasons of availability or low cost. Thus, the skilled artisan will recognize that while the various types of base oils discussed above may be used in the compositions of this invention, they are not necessarily functional equivalents of each other in every instance.

Proportions and Concentrations

[0070] In general, the components of the additive compositions of this invention are employed in the oleaginous liquids (e.g., lubricating oils and functional fluids) in minor amounts sufficient to improve the performance characteristics and properties of the base oil or fluid. In the case of the amines, the amount employed is the amount sufficient to render the pH (determined as described hereinafter) of the finished additive concentrate as formed within the pH ranges set forth hereinabove. The amounts of the other components will vary in accordance with such factors as the use for which the composition is intended, the viscosity characteristics of the base oil or fluid employed, the viscosity characteristics desired in the finished product, the service conditions for which the finished product is intended, and the performance characteristics desired in the finished product. However, generally speaking, the following concentrations (weight percent) of the components (active ingredients, except in the case of viscosity index improvers which are on an as received basis) in the base oils or fluids are illustrative:

	Typical Range	Preferred Range	More Preferred Range
S-contg antiwear/ E.P. agent	0.25 - 5	0.7 - 4.5	1.5 - 4
P-contg antiwear/ E.P. agent	0.05 - 5	0.1 - 4	0.3 - 3
B-contg ashless dispersant	0.05 - 3	0.1 - 2	0.2 - 1.5
Cu corrosion inhibitor	0.001 - 0.25	0.005 - 0.2	0.01 - 0.15
Antioxidant	0 - 4	0 - 2	0 - 1
Rust inhibitor	0 - 0.5	0.001 - 0.4	1 - 0.3
Foam inhibitor	0 - 0.3	0.001 - 0.2	0.005 - 0.1
B-free ashless dispersant	0 - 2	0 - 1.5	0 - 1
Pour point depressant	0 - 5	0 - 4	0 - 3
Viscosity index improver	0 - 35	0 - 25	0 - 15
Friction modifier	0 - 3	0 - 2	0 - 1
Seal swell agent	0 - 20	0 - 20	0 - 15
Dye	0 - 0.1	0 - 0.05	0 - 0.04

[0071] Because the additive concentrates of this invention can be employed in the formulation of lubricants and functional fluid compositions for a wide variety of specialty uses, the above concentration ranges are not intended to limit this invention as departures can readily be made in any situation where a departure is deemed necessary or desirable.

[0072] It will be appreciated that the individual components can be separately blended into the base oil or fluid or can be blended therein in various subcombinations, if desired. Moreover, such components can be blended in the form of separate solutions in a diluent. Except for viscosity index improvers and/or pour point depressants (which are usually blended apart from other components), it is preferable to blend the other selected components into the base oil by use of an additive concentrate of this invention, as this simplifies the blending operations, reduces the likelihood of blending errors, and takes advantage of the compatibility and solubility characteristics afforded by the overall concentrate.

[0073] The additive concentrates of this invention will contain the individual components in amounts proportioned to yield finished oil or fluid blends consistent with the concentrations tabulated above. In most cases, the additive concentrate will contain one or more diluents such as light mineral oils, to facilitate handling and blending of the concentrate. Thus concentrates containing up to 50% by weight of one or more diluents or solvents can be used.

[0074] The oleaginous liquids provided by this invention can be used in a variety of applications. For example, they can be employed as crankcase lubricants, gear oils, hydraulic fluids, manual transmission fluids, automatic transmission fluids, cutting and machining fluids, brake fluids, shock absorber fluids, heat transfer fluids, quenching oils, or transformer oils. The compositions are particularly suitable for use as automotive and industrial gear oils.

Blending

[0075] To make the compositions of this invention, one either purchases or synthesizes each of the respective individual components to be used in the formulation or blending operation. Unless one is already in the commercial manufacture of one or more such components, it is usually simpler and thus preferable to purchase, to the extent possible, the ingredients to be used in the compositions of this invention. If it is desired to synthesize one or more components, use may be made of synthesis procedures referred to in the literature, including, but by no means limited to, the applicable references cited and incorporated herein.

[0076] The formulation or blending operations are relatively simple and involve mixing together in a suitable container or vessel, using a dry, inert atmosphere where necessary or desirable, appropriate proportions of the selected ingredients. Those skilled in the art are cognizant of and familiar with the procedures suitable for formulating and blending additive concentrates and lubricant compositions. Usually the order of addition of components to the blending tank or vessel is not critical provided of course, that the components being blended at any given time are not incompatible or excessively reactive with each other. Agitation such as with mechanical stirring equipment is desirable to facilitate the blending operation. Frequently it is helpful to apply sufficient heat to the blending vessel during or after the introduction of the ingredients thereto, so as to maintain the temperature at, say, 40-60°C, and preferably no higher than about 40°C. Similarly, it is sometimes helpful to preheat highly viscous components to a suitable temperature even before they are introduced into the blending vessel in order to render them more fluid and thereby facilitate their introduction into the blending vessel and render the resultant mixture easier to stir or blend. Naturally the temperatures used during the blending operations should be controlled so as not to cause any significant amount of thermal degradation or unwanted chemical interactions.

[0077] When forming the lubricant compositions of this invention, it is usually desirable to introduce the additive ingredients into the base oil with stirring and application of mildly elevated temperatures, as this facilitates the dissolution of the components in the oil and achievement of product uniformity.

[0078] The following examples illustrate preferred additive concentrates and oleaginous compositions containing such concentrates. These examples are not intended to limit, and should not be construed as limiting, this invention.

EXAMPLE 1

[0079] Stage 1. To a reaction vessel are charged 43.4 parts of sulfurized isobutylene, 4.44 parts of dibutyl hydrogen phosphite, 4.99 parts of C_{12}-C_{14} tertiary alkyl primary amine (Primene 81R; Rohm & Haas Chemical Company), 1.16 parts of 2-ethylhexyl acid phosphate, and 2.56 parts of process oil. Throughout this addition, wherein the sulfurized isobutylene, phosphite and amines are added in the order named, the components of the reaction vessel are agitated. An exothermic reaction occurs on bringing the sulfurized isobutylene, phosphite and amines into contact with each other, and the rate of addition is controlled so that the temperature does not exceed 60°C. Concurrently a slight negative pressure is maintained on the reaction vessel in order to remove any volatiles produced during the exothermic reaction. The temperature of the reaction vessel is maintained at 55-60°C for 60 minutes while continuing the agitation. The mixture is then cooled to 40°C. The pH of the resultant product is approximately 6.9.

[0080] Stage 2. In a separate reactor, 0.69 part of M-544 defoamant (Monsanto Chemical Company), 0.73 part of caprylic acid, 0.50 part of a mixture of C_{12} and C_{14} tert-alkyl primary monoamines (Primene 81R), and 2.87 parts of process oil are agitated together for 15 minutes. The solution so formed is added to the Stage 1 product. Concurrently, added is 19.63 parts of a product formed by reaction of dicyclopentadiene with dithiophosphoric acid-0,0-dialkyl ester in which on a molar basis 40% of the alkyl groups are isopropyl, 40% are isobutyl and 20% are 2-ethylhexyl. Agitation is continued for 15 minutes, and the temperature is kept at 30-40°C. The pH of the resultant solution is approximately 6.9.

[0081] Stage 3. To the agitated solution of Stage 2 is added 3.0 parts of 2,5-dimethylthio-1,3,4-thiadiazole and 16.03 parts of process oil. Agitation is continued for 15 minutes while keeping the temperature at 30-40°C. The finished product is a bright clear amber liquid typically having a sulfur content of about 23.7% (wt) and a phosphorus content of about 2.35% (wt). When dissolved in a refined 650 Solvent Neutral mineral oil at a concentration of 2.15% (wt), the product exhibits a copper corrosion rating of 1b or better in the ASTM D-130 test modified as described hereinafter.

[0082] For automotive gear oil usage, this additive concentrate is preferably used at a treat level of 5.5% by weight based on the total weight of the finished oil. For industrial gear oil usage, the recommended treat level is 2.15% by weight.

EXAMPLE 2

[0083] Stage 1. The procedure of Stage 1 of Example 1 is repeated using 34.97 parts of sulfurized isobutylene, 3.00 parts of dibutyl hydrogen phosphite, 5.60 parts of C_{16-18} alkyl monoamine, 0.01 part of n-octyl amine, 0.98 part of 2-ethylhexyl acid phosphate, and 2.65 parts of process oil.

[0084] Stage 2. The product of Stage 1 is cooled to 40 °C with continued agitation. Added to this product after the temperature reaches 40°C, is 16.61 parts of a product formed by reaction of dicyclopentadiene with dithiophosphoric acid-0,0-dialkyl ester in which on a molar basis 40% of the alkyl groups are isopropyl, 40% are isobutyl and 20% are 2-ethylhexyl.

[0085] Stage 3. In a separate reactor, 0.58 part of M-544 defoamant (Monsanto Chemical Company), 0.62 part of caprylic acid, 0.62 part of a C_{36} dicarboxylic acid (formed by dimerization of oleic acid), and 2.65 parts of process oil are agitated together for 15 minutes. The resulting solution is added to the product from Stage 2. Agitation is continued for 15 minutes. The mixture so formed has a pH in the range of 6.0 to 7.0.

[0086] Stage 4. To the agitated mixture of Stage 3 are added 2.6 parts of 2,5-dimethylthio-1,3,4-thiadiazole and 2.65 parts of process oil. After these two components are added, 0.75 parts of dibutyl hydrogen phosphite is added to the mixture. Agitation is continued for 15 minutes.

[0087] Stage 5. To the agitated mixture of Stage 4 are added 23.07 parts of a mixture composed of 55% (wt) of a boronated succinimide (HiTEC® 648 additive; Ethyl Petroleum Additives, Inc.; Ethyl Petroleum Additives, Ltd.; Ethyl S.A.; Ethyl Canada Ltd.) and 45.% (wt) of process oil, and 2.65 parts of additional process oil. Agitation is continued for 15 minutes to ensure complete blending of the components. The finished product is pumped through a filter. The product is a bright clear amber liquid typically containing, on a weight basis, about 19.3% sulfur, about 2.0% phosphorus, about 0.62% nitrogen, and about 0.16% boron. The product as formed has a pH in the range of 6.0 to 7.0. When dissolved in a refined 650 Solvent Neutral mineral oil at a concentration of 2.54% (wt), the product exhibits a copper corrosion rating of 1b or better in the ASTM D-130 test modified as described hereinafter.

[0088] For automotive gear oil usage, this additive concentrate is preferably used at a treat level of 6.5% by weight

based on the total weight of the finished oil. For industrial gear oil usage, the recommended treat level is 2.5% by weight.

EXAMPLE 3

[0089] Stage 1. The procedure of Stage 1 of Example 1 is repeated using 31.26 parts of sulfurized isobutylene, 2.44 parts of dibutyl hydrogen phosphite, 3.18 parts of C_{16-18} alkyl monoamine, 0.63 part of n-octyl amine, 0.80 part of 2-ethylhexyl acid phosphate, and 5.19 parts of process oil. The pH of the resulting mixture is approximately 7.0.

[0090] Stage 2. In a separate reactor, 0.47 part of M-544 defoamant (Monsanto Chemical Company), 0.51 part of caprylic acid, 0.51 part of C_{36} dicarboxylic acid (formed by dimerization of oleic acid), and 5.19 parts of process oil are agitated together for 15 minutes. The solution so formed is added to the Stage 1 product. Concurrently, added is 10.66 parts of a product formed by reaction of dicyclopentadiene with dithiophosphoric acid-0,0-dialkyl ester in which on a molar basis 40% of the alkyl groups are isopropyl, 40% are isobutyl and 20% are 2-ethylhexyl. Agitation is continued for 60 minutes, and the temperature is kept at 40°C. The pH of the resultant solution is approximately 6.9.

[0091] Stage 3. To the agitated solution of Stage 2 is added 2.14 parts of 2,5-dimethylthio-1,3,4-thiadiazole and 5.19 parts of process oil. Then 0.61 part of dibutyl hydrogen phosphite is added to the mixture. Agitation is continued for 15 minutes.

[0092] Stage 4. To the agitated solution from Stage 3 are added 10.32 parts of a mixture composed of 55% (wt) of a boronated succinimide (HiTEC® 648 additive; Ethyl Petroleum Additives, Inc.; Ethyl Petroleum Additives, Ltd.; Ethyl S.A.; Ethyl Canada Ltd.) and 45.% (wt) of process oil, 6.24 parts of alkenylsuccinimide (formed from ammonia and alkenyl succinic anhydride produced from a mixture of olefins made by isomerizing a 1-olefin mixture containing 49% C_{20}, 42% C_{22}, and 8% C_{24} 1-olefins, and 14.66 parts of additional process oil. Agitation is continued for 15 minutes to ensure complete blending of the components. The finished product is pumped through a filter. The product is a bright clear amber liquid typically containing, on a weight basis, about 17.5% sulfur, and about 1.6% phosphorus. The product as formed has a pH in the range of 6.60 to 6.9. When dissolved in a refined 650 Solvent Neutral mineral oil at a concentration of about 3.1% (wt), the product exhibits a copper corrosion rating of 1b or better in the ASTM D-130 test modified as described hereinafter.

[0093] For automotive gear oil usage, this additive concentrate is preferably used at a treat level of 8% by weight based on the total weight of the finished oil. For industrial gear oil usage, the recommended treat level is 3.1% by weight.

[0094] The procedure used in determining pH in accordance with this invention involves diluting the sample of the composition in a mixture of methanol and toluene and then assaying "non-aqueous" pH with a conventional pH probe as used in aqueous systems. For this purpose, the basic equipment used is a potentiometer such as Beckman Zero-matic IV pH meter, Beckman Instruments Inc., available from CMS, catalog number 257-902, or equivalent; a glass indicating electrode 0-11 pH range, available from CMS, catalog number 39322 or equivalent; indicating electrode cable, available from Beckman Instruments Inc., catalog number 598979, or equivalent; saturated calomel reference electrode with ground glass sleeve junction, available from CMS, cataloge number 39420, or equivalent; and reference electrode cable, available from Beckman Instruments Inc., catalog number 598982, or equivalent. The reagents used in this procedure are reagent grade toluene; potassium chloride; reagent grade methanol; buffer solution, pH 7.00, available from CMS, catalog number 061-622, or equivalent; buffer solution, pH 10.00, available from CMS, catalog number 061-648, or equivalent; and buffer solution, pH 4.00, available from CMS, catalog number 061-614, or equivalent. The steps used in the procedure are as follows:

A. If the sample solution is expected to fall between the pH of 4.0 and 7.0, standardize the pH meter with these pH buffers. If the sample solution is expected to fall between the pH of 7.0 and 10.0, standardize the pH meter with these pH buffers. In standardizing with buffers standardize first with the buffer having a pH more remote from the suspected pH of the sample than the other buffer, and then use that other buffer.
B. It is important to have a linear range over which the measurements are to be made. Therefore, repeat all of step A until no adjustments are needed in order to have a linear pH scale.
C. Rinse the electrodes with distilled water, and blot dry with a clean, dry tissue.
D. Using a top loading balance, weigh 1.0 ± 0.05 g of sample into a 150-mL beaker.
E. Add 50.0 mL by graduated cylinder of 1:1 volume of toluene and methanol. Alternatively, dissolve in 25.0 mL of toluene and then further dilute with 25.0 mL of methanol.
F. Place a stirring bar into the beaker containing the sample and solvents and place on a magnetic stirrer.
G. Insert the electrodes, turn on the pH meter, and stir for one minute.
H. Record the pH to the nearest 0.05 pH unit.
I. If recording more than one pH, rinse the electrodes with heptane, and with distilled water, and then blot dry with tissue, and then repeat steps F to H. When measurements have been completed, rinse the electrodes with distilled water and immerse them in a beaker of water for storage.

[0095] Copper corrosion ratings for the purposes of this invention are conducted using the standard ASTM D-130 procedure modified to the extent that the additive concentrate to be tested is first stored in an oven for 120 hours at 65°C. Then the concentrate is blended into the test oil to the selected test concentration and the test is conducted at 121°C.

[0096] The enhanced storage stability of the additive compositions of this invention was demonstrated in a series of storage tests. In these tests, an additive composition formed as in Example 2 was stored at ambient temperatures, in one case while in an open container exposed to the atmosphere and in another case, in an open container under conditions of 100% relative humidity. Also subjected to these storage tests were samples of the corresponding additive composition which did not contain sufficient amine to achieve the pH conditions of this invention but instead had a pH of in the range of 5.3 to 5.9. The results of these tests are shown in the following table.

RESULTS OF STORAGE TESTS		
Composition	Time to Haze Formation; Exposure to Air	Time to Haze Formation; Exposure to 100% Humidity
This Invention	10 Days	2 Days
Not of This Invention	1 Day	1.5 Hours

Claims

1. A process of forming an additive concentrate from a plurality of oil-soluble components which include at least one acidic organic component and at least one boronated ashless dispersant by blending the components of the concentrate concurrently or sequentially and individually or in one or more sub-combinations,
characterised in that the process comprises:

(a) including as at least one component in such blending operation a sufficient amount of oil-soluble amine to adjust the pH of the concentrate to at least 6.0, and
(b) blending the boronated ashless dispersant into the concentrate such that at no point in the blending is the boronated ashless dispersant exposed to a pH below 6.0.

2. A process according to claim 1 wherein in (a) the pH of the concentrate is 6.0 to 7.0.

3. A process according to claim 1 or 2 wherein the at least one oil-soluble, acidic organic additive is a hydrocarbyl phosphoric acid or a carboxylic acid.

4. A process according to any one of claims 1 to 3 wherein the plurality of oil-soluble components further includes at least one oil-soluble active sulfur-containing antiwear and/or extreme pressure agent and at least one oil-soluble phosphorus-containing antiwear and/or extreme pressure agent.

5. A process according to claim 4 wherein the sulfur-containing antiwear and/or extreme pressure agent is a sulfurized isobutylene, the phosphorus-containing antiwear and/or extreme pressure agent is an amine salt of dibutyl monothiophosphoric acid, the at least one acidic component comprises a combination of di-2-ethylhexylphosphoric acid and mono-2-ethylhexylphosphoric acid and a dimer acid having about 36 carbon atoms in the molecule, the oil-soluble amine is an aliphatic monoamine having from 8 to 24 carbon atoms in the molecule, the boronated ashless dispersant is a boronated succinimide formed by boronating a succinimide ashless dispersant formed by reacting (i) a polyisobutenyl succinic acylating agent derived from polyisobutene having a number average molecular weight in the range of 500 to 5,000 with (ii) a mixture of cyclic and acyclic polyethylene polyamines having an approximate average overall composition in the range of diethylene triamine to pentaethylene hexamine, and wherein the plurality of oil-soluble components further comprises at least one oilsoluble copper corrosion inhibitor in an amount such that the resultant concentrate exhibits a 1b rating or better in the ASTM D-130 procedure.

6. A process according to claim 5 wherein the polyisobutene has a number average molecular weight in the range of 700 to 2,500, the mixture of cyclic and acyclic polyethylene polyamines has an approximate average overall composition of tetraethylene pentamine, and wherein the succinimide ashless dispersant is boronated by reaction with boric acid.

7. A process according to claim 5 or 6 wherein the copper corrosion inhibitor comprises 2,5-dimethylthio-1,3,4-thiadizole.

8. An additive concentrate obtainable by the method claimed in any one of claims 1 to 7.

9. An additive concentrate comprising at least one oil-soluble amine salt of a dihydrocarbyl monothiophosphoric acid in a sufficient amount to provide a concentrate having a pH of 6.0 to 7.0, at least one oil-soluble active-sulfur-containing antiwear and/or extreme pressure agent, one or more oil-soluble acidic organic additives at least one of which is a hydrocarbyl phosphoric acid or a carboxylic acid and, as optional components:

   at least one copper corrosion inhibitor in an amount such that the concentrate exhibits a 1b rating or better in the ASTM D-130 procedure;
   at least one oil-soluble succinimide;
   at least one oil-soluble succinic ester; and/or
   at least one oil-soluble succinic ester-amine.

10. A process for preparing a concentrate as claimed in claim 9 which comprises:

   (A) forming an oil-soluble amine salt of a dihydrocarbyl monothiophosphoric acid by:

      (i) introducing at a rate such that the temperature does not exceed about 60°C while agitating the mixture so formed, one or more hydrocarbyl hydrogen phosphites into an excess quantity of one or more active sulfur-containing antiwear and/or extreme pressure agents.
      (ii) introducing into this mixture, at a rate such that the temperature does not exceed about 60°C, one or more aliphatic primary monoamines having from 8 to 24 carbon atoms per molecule while agitating the mixture so formed; and
      (iii) maintaining the temperature of the resultant agitated reaction mixture at between 55 to 60°C until reaction is substantially complete; and

   (B) blending the amine salt formed with one or more oil-soluble acidic organic additives at least one of which is a hydrocarbyl phosphoric acid or a carboxylic acid molecule and, as optional components, with:

      at least one oil-soluble copper corrosion inhibitor in an amount such that the concentrate exhibits a 1b rating or better in the ASTM D-130 procedure;
      at least one oil-soluble succinimide;
      at least one oil-soluble succinic ester; and/or
      at least one oil-soluble succinic ester-amine.

Patentansprüche

1. Verfahren zur Herstellung eines Additivkonzentrats aus einer Vielzahl öllöslicher Komponenten, die mindestens eine säurebildende organische Komponente und mindestens ein boriertes aschefreies Dispergiermittel einschließen, durch gleichzeitiges oder aufeinanderfolgendes Mischen der Komponenten des Konzentrats einzeln oder in einer oder mehreren Unterkombinationen, dadurch gekennzeichnet, daß man bei dem Verfahren

   (a) in einem solchen Mischverfahren als mindestens eine Komponente eine ausreichende Menge eines öllöslichen Amins mitverwendet, um den pH des Konzentrats auf mindestens 6,0 einzustellen, und

   (b) das borierte aschefreie Dispergiermittel so in das Konzentrat einmischt, daß das borierte aschefreie Dispergiermittel zu keinem Zeitpunkt während des Mischens einem pH von weniger als 6,0 ausgesetzt ist.

2. Verfahren nach Anspruch 1, bei dem in (a) der pH des Konzentrats 6,0 bis 7,0 beträgt.

3. Verfahren nach Anspruch 1 oder 2, bei dem das mindestens eine öllösliche säurebildende organische Additiv eine Hydrocarbylphosphorsäure oder eine Carbonsäure ist.

4. Verfahren nach einem der Ansprüche 1 bis 3, bei dem die Vielzahl öllöslicher Komponenten außerdem mindestens

ein öllösliches aktiven Schwefel enthaltendes Mittel gegen Verschleiß und/oder zur Verwendung bei extremem Druck und mindestens ein öllösliches phosphorhaltiges Mittel gegen Verschleiß und/oder zur Verwendung bei extremem Druck einschließt.

5. Verfahren nach Anspruch 4, bei dem das schwefelhaltige Mittel gegen Verschleiß und/oder zur Verwendung bei extremem Druck ein geschwefeltes Isobutylen ist, das phosphorhaltige Mittel gegen Verschleiß und/oder zur Verwendung bei extremem Druck ein Aminsalz von Dibutylmonothiophosphorsäure ist, die mindestens eine säurebildende Komponente eine Kombination aus Di-2-ethylhexylphosphorsäure und Mono-2-ethylhexylphosphorsäure und eine Dimersäure mit etwa 36 Kohlenstoffatomen im Molekül umfaßt, das öllösliche Amin ein aliphatisches Monoamin mit 8 bis 24 Kohlenstoffatomen im Molekül ist, das borierte aschefreie Dispergiermittel ein boriertes Succinimid ist, das durch Borieren eines aschefreien Succinimiddispergiermittels hergestellt wird, das durch Umsetzen von (i) einem von Polyisobuten abgeleiteten Polyisobutenylbernsteinsäure-Acylierungsmittel mit einem zahlenmittleren Molekulargewicht im Bereich von 500 bis 5.000 mit (ii) einer Mischung aus cyclischen und acyclischen Polyethylenpolyaminen mit einer ungefähren durchschnittlichen Gesamtzusammensetzung im Bereich von Diethylentriamin bis Pentaethylenhexamin gebildet wurde, und wobei die Vielzahl öllöslicher Komponenten außerdem mindestens einen öllöslichen Kupferkorrosionsinhibitor in einer solchen Menge enthält, daß das resultierende Konzentrat im ASTM D-130 Verfahren die Bewertung 1b oder besser aufweist.

6. Verfahren nach Anspruch 5, bei dem das Polyisobuten ein zahlenmittleres Molekulargewicht im Bereich von 700 bis 2.500 aufweist, das Gemisch aus cyclischen und acyclischen Polyethylenpolyaminen eine ungefähre durchschnittliche Gesamtzusammensetzung von Tetraethylenpentamin hat und das aschefreie Succinimiddispergiermittel durch Umsetzen mit Borsäure boriert wird.

7. Verfahren nach Anspruch 5 oder 6, bei dem der Kupferkorrosionsinhibitor 2,5-Dimethylthio-1,3,4-thiadizol umfaßt.

8. Additivkonzentrat, das durch das Verfahren nach einem der Ansprüche 1 bis 7 hergestellt werden kann.

9. Additivkonzentrat, enthaltend mindestens ein öllösliches Aminsalz einer Dihydrocarbylmonothiophosphorsäure in ausreichender Menge, um ein Konzentrat mit einem pH von 6,0 bis 7,0 zur Verfügung zu stellen, mindestens ein öllösliches aktiven Schwefel enthaltendes Mittel gegen Verschleiß und/oder zur Verwendung bei extremem Druck, eines oder mehrere öllösliche säurebildende organische Additive, von denen mindestens eines eine Hydrocarbylphosphorsäure oder eine Carbonsäure ist, sowie als bei Bedarf eingesetzte Komponenten:

mindestens einen Kupferkorrosionsinhibitor in einer solchen Menge, daß das Konzentrat im ASTM D-130 Verfahren eine Bewertung von 1b oder besser erhält;

mindestens ein öllösliches Succinimid;

mindestens einen öllöslichen Bernsteinsäureester und/oder

mindestens ein öllösliches Bernsteinsäureesteramin.

10. Verfahren zur Herstellung eines Konzentrats nach Anspruch 9, bei dem man

(A) ein öllösliches Aminsalz einer Dihydrocarbylmonothiosphosphorsäure herstellt, indem man

(i) eines oder mehrere Hydrocarbylhydrogenphosphite mit einer solchen Geschwindigkeit in eine überschüssige Menge eines oder mehrerer aktiven Schwefel enthaltenden Mittel(s) gegen Verschleiß und/oder zur Verwendung bei extremem Druck einbringt, daß die Temperatur 60°C nicht übersteigt, während das auf diese Weise hergestellte Gemisch gerührt wird;

(ii) in dieses Gemisch eines oder mehrere aliphatische primäre Monoamine mit 8 bis 24 Kohlenstoffatomen pro Molekül mit einer solchen Geschwindigkeit einbringt, daß die Temperatur etwa 60°C nicht übersteigt, während das auf diese Weise hergestellte Gemisch gerührt wird, und

(iii) die Temperatur des resultierenden gerührten Reaktionsgemischs zwischen 55 und 60°C hält, bis die Reaktion im wesentlichen abgeschlossen ist, und

(B) das hergestellte Aminsalz mit einem oder mehreren öllöslichen säurebildenden organischen Additiven, von denen mindestens eines eine Hydrocarbylphosphorsäure oder ein Carbonsäuremolekül ist, sowie ggfs. folgenden Komponenten mischt:

mindestens einem öllöslichen Kupferkorrosionsinhibitor in einer solchen Menge, daß das Konzentrat im ASTM D-130 Verfahren eine Bewertung von 1b oder besser erhält;

mindestens einem öllöslichen Succinimid;

mindestens einem öllöslichen Bernsteinsäureester und/oder

mindestens einem öllöslichen Bernsteinsäureesteramin.

Revendications

1. Procédé de formation d'un concentré d'additifs à partir d'une pluralité de composants oléosolubles qui comprennent au moins un composant organique acide et au moins un dispersant boré sans cendres, en mélangeant les composants du concentré concurremment ou successivement et individuellement ou sous la forme d'une ou plusieurs sous-combinaisons, caractérisé en ce qu'il comprend les étapes consistant à :

   (a) inclure, en tant que composant, au nombre d'au moins un, dans une telle opération de mixtion, une quantité suffisante d'amine oléosoluble pour ajuster le pH du concentré à au moins 6,0 et
   (b) mélanger le dispersant bore sans cendres dans le concentré de telle façon qu'à aucun moment de l'opération de mixtion, le dispersant bore sans cendres soit exposé à un pH inférieur à 6,0.

2. Procédé selon la revendication 1, dans lequel, pendant l'étape (a), le pH du concentré est de 6,0 à 7,0.

3. Procédé selon la revendication 1 ou 2, dans lequel l'additif organique acide oléosoluble, au nombre d'au moins un, est un acide hydrocarbylphosphorique ou un acide carboxylique.

4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel la pluralité de composants oléosolubles comprend, en outre, au moins un agent anti-usure et/ou extrême pression oléosoluble contenant du soufre actif et au moins un agent anti-usure et/ou extrême pression oléosoluble contenant du phosphore.

5. Procédé selon la revendication 4, dans lequel l'agent anti-usure et/ou extrême pression contenant du soufre est un isobutylène sulfurisé, l'agent anti-usure et/ou extrême pression contenant du phosphore est un sel aminé d'acide dibutylmonothiophosphorique, le composant acide, au nombre d'au moins un, comprend une combinaison d'acide di-2-éthyl-hexylphosphorique et d'acide mono-2-éthylhexylphosphorique et d'un acide dimère ayant environ 36 atomes de carbone dans la molécule, l'amine oléosoluble est une monoamine aliphatique ayant de 8 à 24 atomes de carbone dans la molécule, le dispersant boré sans cendres est un succinimide boré formé par boration d'un dispersant succinimide sans cendres formé par réaction de (i) un agent acylant polyisobuténylé succinique provenant d'un polyisobutène ayant un poids moléculaire moyen compris entre 500 et 5 000 avec (ii) un mélange de polyéthylène-polyamines cycliques et acycliques ayant une composition globale moyenne approximative allant d'une diéthylènetriamine à une pentaéthylènehexamine, et dans lequel la pluralité de composants oléosolubles comprend, en outre, au moins un inhibiteur de corrosion du cuivre, oléosoluble, en une quantité telle que le concentré résultant ait la classification 1b ou mieux dans le mode opératoire ASTM D-130.

6. Procédé selon la revendication 5, dans lequel le polyisobutène a un poids moléculaire moyen en nombre compris entre 700 et 2 500, le mélange de polyéthylène-polyamines cycliques et acycliques a une composition globale moyenne approximative de tétraéthylènepentamine, et dans lequel le dispersant sans cendres succinimide est boré par réaction avec de l'acide borique.

7. Procédé selon la revendication 5 ou 6, dans lequel l'inhibiteur de corrosion du cuivre comprend du 2,5-diméthylthio-1,3,4-thiadiazole.

8. Concentré d'additifs pouvant être obtenu au moyen du procédé selon l'une quelconque des revendications 1 à 7.

9. Concentré d'additifs comprenant au moins un sel aminé oléosoluble d'un acide dihydrocarbylmonothiophosphorique en une quantité suffisante pour fournir un concentré ayant un pH de 6,0 à 7,0, au moins un agent anti-usure et/ou extrême pression oléosoluble contenant du soufre actif, un ou plusieurs additifs organiques acides oléosolubles, dont au moins un est un acide hydrocarbylphosphorique ou un acide carboxylique et, comme composants facultatifs :

   au moins un inhibiteur de corrosion du cuivre en une quantité telle que le concentré ait la classification 1b ou mieux dans le mode opératoire ASTM D-130 ;
   au moins un succinimide oléosoluble ;
   au moins un ester succinique oléosoluble ; et/ou
   au moins une combinaison ester succinique-amine oléosoluble.

10. Procédé de préparation d'un concentré selon la revendication 9, comprenant :

   (A) la formation d'un sel aminé oléosoluble d'un acide dihydrocarbylmonothiophosphorique par :

      (i) introduction d'un ou plusieurs hydrogénophosphites d'hydrocarbyle dans une quantité excédentaire d'un ou plusieurs agents anti-usure et/ou extrême pression contenant du soufre actif, à une vitesse telle que la température ne dépasse pas environ 60°C, tout en agitant le mélange ainsi formé,
      (ii) introduction d'une ou plusieurs monoamines primaires aliphatiques ayant de 8 à 24 atomes de carbone par molécule, dans ce mélange, à une vitesse telle que la température ne dépasse pas environ 60°C et tout en agitant le mélange ainsi formé ; et
      (iii) le maintien du mélange de réaction résultant, sous agitation, à une température comprise entre 55 et 60°C jusqu'à ce que la réaction soit pratiquement terminée ; et

   (B) la mixtion du sel aminé formé avec un ou plusieurs additifs organiques acides oléosolubles dont au moins un est un acide hydrocarbylphosphorique ou une molécule d'acide carboxylique et, comme composants facultatifs, avec :

      au moins un inhibiteur de corrosion du cuivre, oléosoluble, en une quantité telle que le concentré ait la classification 1b ou mieux dans le mode opératoire ASTM D-130 ;
      au moins un succinimide oléosoluble ;
      au moins un ester succinique oléosoluble ; et/ou
      au moins un ester succinique-amine oléosoluble.